Copper clad stainless wires thermal contraction **RLS 10/24/2008**

Will copper cladding delaminate when cold due to thermal contraction?

Contraction integrals from 300K to 80K:

Copper contraction 313e-5 ΔL/L

Stainless contraction 290e-5 ΔL/L

Assuming the cladding is much thinner than the stainless, all strain is in the copper.
Assuming the temperature is isothermal.
Then the copper is strained to match the length of the stainless.

$$stress = E * \Delta L / L$$

$$stress = 15.6e-6\, psi * (313e-5 - 290e-5)$$

$$stress = 3590\, psi$$

This is a low stress for copper, but whether it would delaminate depends on the bond strength and if the wire is isothermal. Testing should involve at least ten rapid thermal cycles by dunking into liquid nitrogen. This is more severe than conditions inside the Microboone cryostat.

Wire Testing Procedure **11/6/2008**

The wire is copper clad stainless. The purpose of this test is to find out if copper delaminates when thermally shocked.

1. Cut a six inch length of wire.
2. Visually inspect for cracks or defects with a microscope.
3. Quickly submerge the wire in liquid nitrogen.
4. After it is cold, at least five seconds submerge, withdraw
5. Allow to warm to room temperature in air.
6. Repeat until the sample has been dunked ten times.
7. Visually inspect for cracks or defects with a microscope.
8. If no defects found, prepare a longer wire sample, at least five feet long wrapped around a electrically insulating tube.
9. Measure the resistance with secure connections
10. Dunk the wire into liquid nitrogen ten times, measuring the resistance.

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Nov. 10, 2008

MicroBoone Wire Test

As per the testing procedure, a 6” length of wire was cut and inspected under a microscope.
It was submerged in liquid nitrogen for 10 seconds and allowed to return to room temperature.
This was repeated for 10 cycles with a microscopic inspection after each cycle.
No flaking or defects were seen.
Next, a 5 foot piece of wire was wrapped around a piece of threaded nylon rod and 22 awg wire was soldered to each end. (see Fig. 1)
This was connected via test leads to an HP 3457A DMM.
The resistance was recorded. (see Table 1)
This was submerged in liquid nitrogen for 20 seconds,(see Fig. 2) the resistance was recorded, and then allowed to return to room temperature. (see Fig. 3)
This was repeated for 10 cycles.
After 5 cycles it was noted that the resistance readings were changing slightly when the test leads were moved.
During the 6^{th} cycle, the test leads were removed and the 22 awg wires were connected directly to the HP 3457 terminals. The readings stabilized.

Cycle #	Room Temp Resistance	77K Resistance	Notes
1	18.2	5.4	
2	18.3	5.4	
3	18.3	5.4	
4	18.3	4.9	
5	18.3	4.8	
6	18.3	4.3	Changed leads.
7	17.3	4.4	
8	17.3	4.4	
9	17.7	4.3	
10	17.5	4.3	

Table 1

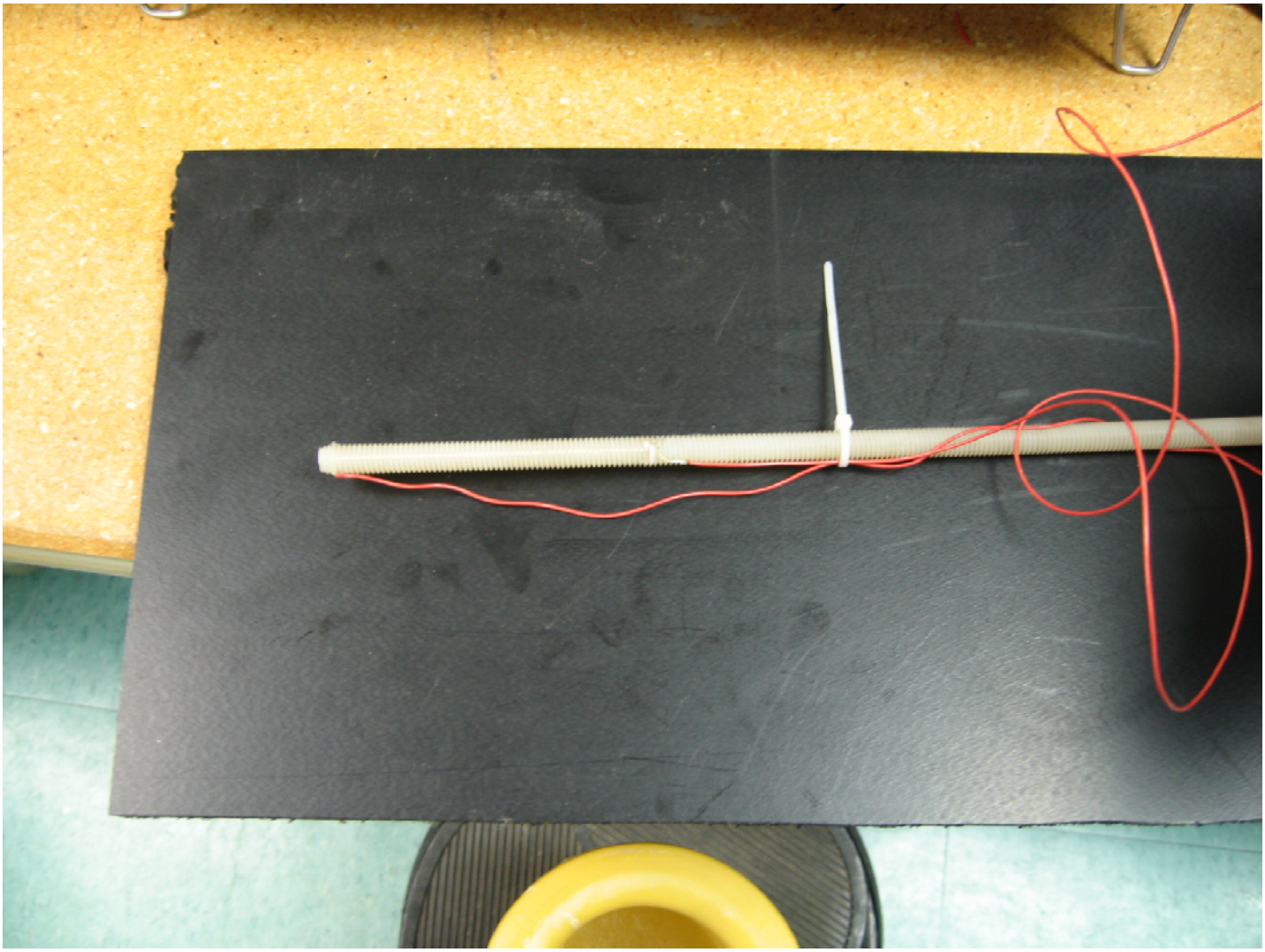

Fig. 1

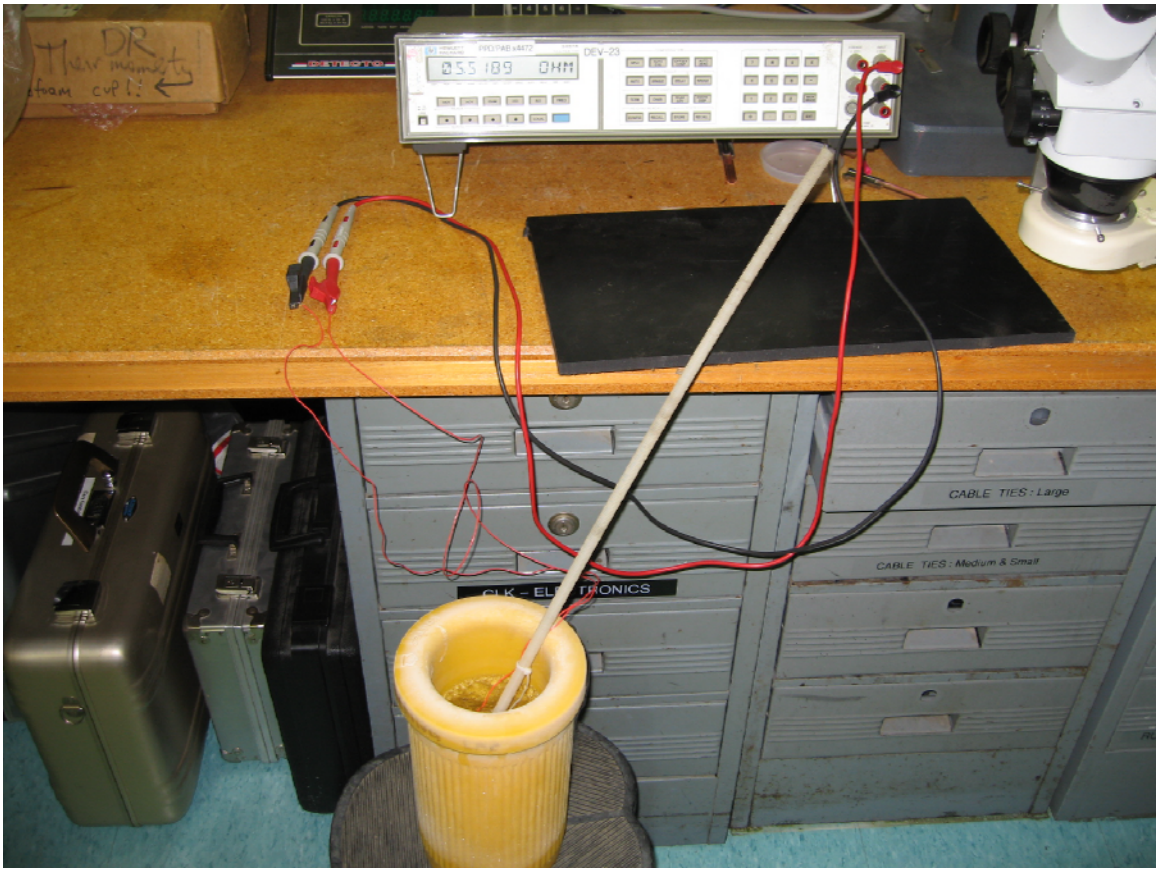
CABLE TIES : Large
CABLE TIES : Medium & Small

Fig. 2


CABLE TIES : Large
CABLE TIES : Medium & Small
VACUUM PART
VACUUM GAUGES
RUBBER STOPPERS & RUBBER HOSE

Fig. 3

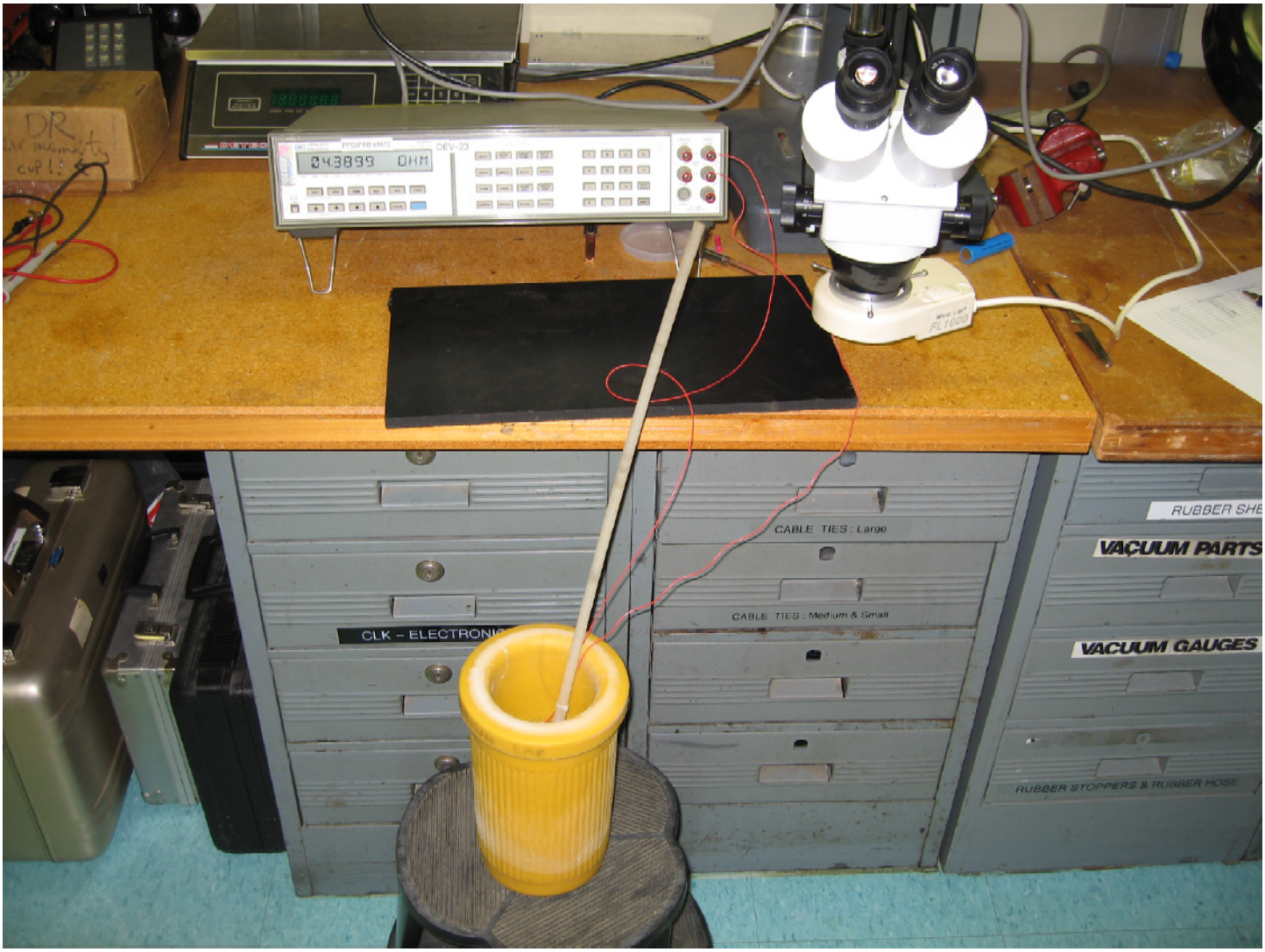
043899 OHM
CABLE TIES : Large
CABLE TIES : Medium & Small
VACUUM PARTS
VACUUM GAUGES
RUBBER STOPPERS & RUBBER HOSE

Fig. 4


DR
173293 OHM
CABLE TIES : Large
CABLE TIES : Medium & Small
CLK – ELECTRONICS

Fig. 5